NOAA Technical Memorandum NWS ER-64

WIND FORECASTING FOR THE
MONONGAHELA NATIONAL FOREST

Scientific Services Division
Eastern Region Headquarters
ust 1977

noaa NATIONAL OCEANIC AND / National Weather
ATMOSPHERIC ADMINISTRATION / Service

NOAA TECHNICAL MEMORANDA
National Weather Service, Eastern Region Subseries

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Papers 1 to 22 are in the former series, ESSA Technical Memoranda, Eastern Region Technical Memoranda (ERTM); papers 23 to 37 are in the former series, ESSA Technical Memoranda, Weather Bureau Technical Memoranda (WBTM). Beginning with 38, the papers are now part of the series, NOAA Technical Memoranda NWS.

Papers 1 to 22 are available from the National Weather Service Eastern Region, Scientific Services Division, 585 Stewart Avenue, Garden City, N.Y. 11530. Beginning with 23, the papers are available from the National Technical Information Service, U.S. Department of Commerce, Sills Bldg., 5285 Port Royal Road, Springfield, Va. 22151. Prices vary for paper copy, $2.25 microfiche. Order by accession number shown in parentheses at end of each entry.

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WBTM ER 23 A Study of the Effect of Sea Surface Temperature on the Areal Distribution of Radar Detected Precipitation Over the South Carolina Coastal Waters. Edward Paquet. June 1967 (PB-180-612)

WBTM ER 24 An Example of Radar as a Tool in Forecasting Tidal Flooding. Edward P. Johnson. August 1967 (PB-180-618)

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WBTM ER 31 A Study of the Areal Distribution of Radar Detected Precipitation at Charleston, S.C. S.K. Parrish and M.A. Lopez. October 1968 (PB-180-480)

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WBTM ER 35 Objective Forecasts of Precipitation Using PE Model Output. Stanley E. Wasserman. July 1970 (PB-193-378)

WBTM ER 36 Summary of Radar Echoes in 1967 Near Buffalo, N.Y. Richard K. Sheffield. September 1970 (COM-71-00310)

WBTM ER 37 Objective Mesoscale Temperature Forecasts. Joseph P. Sobel. September 1970 (COM-71-0074)

NOAA Technical Memoranda NWS

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NWS ER 45 Forecasting Type of Precipitation. Stanley E. Wasserman. January 1972 (COM-72-10316)

NWS ER 46 An Objective Method of Forecasting Summertime Thunderstorms. John F. Townsend and Russell J. Younkin. May 1972 (COM-72-10765)

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NWS ER 49 A Procedure for Improving National Meteorological Center Objective Precipitation Forecasts. Joseph A. Ronco, Jr. November 1972 (COM-73-10182)

NWS ER 50 PEATMOS Probability of Precipitation Forecasts as an Aid in Predicting Precipitation Amounts. Stanley E. Wasserman. December 1972 (COM-73-10243)

NWS ER 51 Frequency and Intensity of Freezing Rain/Drizzle in Ohio. Marvin E. Miller. February 1973 (COM-73-10570)

NWS ER 52 Forecast and Warning Utilization of Radar Remote Facsimile Data. Robert E. Hamilton. July 1973 (COM-73-11275)

NWS ER 53 Summary of 1969 and 1970 Public Severe Thunderstorm and Tornado Watches Within the National Weather Service, Eastern Region. Marvin E. Miller and Lewis H. Ramey. October 1973 (COM-74-10160)

NWS ER 54 A Procedure for Improving National Meteorological Center Objective Precipitation Forecasts - Winter Season. Joseph A. Ronco, Jr. November 1973 (COM-74-10200)

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NWS ER 56 Biometeorological Factors Affecting the Development and Spread of Plant Diseases. V. J. Valli. July 1974 (COM-74-11625/AS)

NWS ER 57 Heavy Fall and Winter Rain In The Carolina Mountains. David B. Gilhousen. October 1974 (COM-74-11761/AS)

NWS ER 58 An Analysis of Forecasters' Propensities In Maximum/Minimum Temperature Forecasts. I. Randy Racer. November 1974 (COM-75-10063/AS)

(Continued On Inside Rear Cover)

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WIND FORECASTING FOR THE
MONONGAHELA NATIONAL FOREST

Donald E. Risher
WSFO Charleston, WV

Scientific Services Division
Eastern Region Headquarters
August 1977

WIND FORECASTING FOR THE MONONGAHELA NATIONAL FOREST

Donald E. Risher
WSFO Charleston, West Virginia

ABSTRACT. An objective statistical technique for pro-
ducing 42-hour surface wind forecasts for Fire Danger
Stations in the Monongahela National Forest from National
Weather Service Numerical Meteorological Center's 0000 GMT
FOUS guidance for Elkins, West Virginia is described and
evaluated.

1. INTRODUCTION

It is generally recognized that one of the most critical forecast
parameters in the National Weather Service Fire Weather Forecast
Program is that of wind speed, and to a lesser degree, direction.

At NWS Forecast Offices having fire weather forecast responsibility,
we frequently find forecasters with little experience at the fire
weather forecast desk. This study was developed to help eliminate,
at WSFO Charleston, an apparent tendency to overforecast wind speeds
at the three National Forest Service Fire Danger Stations in the
Monongahela National Forest.

The Monongahela Forest stretches over 820,000 acres of West Virginia
within the Allegheny Mountain range (see Figure 1). Elevation within
the forest ranges from near 1,000 feet (305 m) MSL in the Eastern
Panhandle to near 5,000 feet (1,524 m) at Spruce Knob. Marlinton at
2,200 feet (671 m) and Bartow at 2,760 feet (841 m) lie along the
Greenbrier River in east central West Virginia, while Petersburg at
1,050 feet (320 m) lies along the South Branch of the Potomac River
in the west portions of the Eastern Panhandle.

2. BACKGROUND

Since early 1973, the Techniques Development Laboratory of the
National Weather Service has been producing objective forecasts of
surface winds for the conterminous United States. Techniques de-
veloped are currently described in Technical Procedures Bulletins
Nos. 150 and 191.

Twice daily during 1974 and 1975 at approximately 3:00 A.M. and
3:00 P.M. local time these wind forecasts were received over tele-
type at the forecast office in Charleston. Locations for which fore-
casts are prepared include Charleston, Huntington, Beckley and Elkins.

Fire weather forecasts are made for a specific time, i.e., for 1800
GMT and released between 2:00 and 2:30 P.M. local time each day.

3. OBJECTIVE TECHNIQUE DEVELOPMENT, DESCRIPTION AND APPLICATION

During the first two years of this study (1974 and 1975) the 1200 GMT FOUS 22 forecast package which contained surface winds forecasts was received too late for use in the fire weather program; therefore, the 0000 GMT FOUS 22 forecast package was used as a guidance for 1800 GMT tomorrow (42 hours) from today's 0000 GMT run. Since early 1976 a final FOUS 12 (which contains the surface wind forecasts) from 1200 GMT data has become available as early as 1800 GMT and is being used along with the earlier 0000 GMT forecasts. Beginning April 1977 the early guidance surface wind forecasts in the early FOUS 12 message was extended out to 36 hours. Wind speed data for this report came from various sources and was used as received in units of knots (kts) or miles-per-hour (mph). In order to prepare a unified paper, conversion to the proposed National Weather Service metric standard, kilometers per hour (km/h) was made where appropriate.

A. Data Collected, Tabulated and Examined for Relationships

Verification of the 1974 and 1975 42-hour 0000 GMT FO22 wind speed forecasts (valid time 1800Z) for Elkins are presented in Tables 1 and 2. Table 1 shows the average absolute error (AVG ABS ERR) for the two-year period to be 2.9 knots (5.4 km/h). Table 2 shows that during 1974 and 1975, 46 percent of the 42-hour wind direction forecasts at Elkins were from the west. Complete tabulation of the direction forecasts between 250 degrees and 300 degrees is presented in Table 3. Verification data used in preparing Tables 1 through 3 were extracted from fire weather records, which, because of their standard operating procedures, give wind direction to an eight-point compass. Table 4 is a computation of wind speed error at Elkins for the 42-hour 0000 GMT FO22 output during 1974 and 1975. Data was obtained from air pollution daily work sheets. Considerable data was missing due to weekends, holidays and/or computer failures. Percentage of forecast winds within 3 knots (6 km/h) of the observed winds for all wind speeds are listed in Table 4 with separate tabulations for categories of wind speeds in excess of 7 knots (13 km/h). After determining the quality of the 42-hour 0000 GMT FO22 forecasts for Elkins, valid at 1800Z the following day, perfect prog relationships were developed between observed wind direction and speeds at Elkins and those observed within the Monongahela National Forest.

B. Wind Speed Relationships Displayed Graphically for Easy Application

Figures 2, 3 and 4 show the 1800 GMT average relations between observed wind speeds respectively at the three National Forest Service Fire Danger Stations at Marlinton, Bartow and Petersburg versus Elkins using two wind roses. The left wind rose is for all wind speeds, the right wind rose is for wind speeds in excess of 10 mph (16 km/h). For example, with a forecast north wind at 20 mph (32 km/h) forecast at Elkins, Figure 3 [right rose (>10 mph)] would indicate the forecast

speed for Marlinton should be 13 mph (21 km/h) (i.e., 20 x 0.65 =
13 mph (32.2 x 0.65 ≃ 21 km/h)). All data for Figures 2 through 7
was obtained from the normal fire seasons for the Monongahela National
Forest. The spring season runs from early March through late May;
the fall season runs from early October through early December.

C. Wind Direction Relationships Displayed
Graphically for Easy Application

Figures 5, 6 and 7 show the actual distribution of observed 1800
GMT wind directions respectively at Petersburg, Marlinton and Bartow
for each of the eight-point compass wind directions observed at
Elkins. These frequency distribution tables can be most useful to
the fire weather forecaster. (See Figure 6. For example, if the
wind is forecast from the northwest in Elkins, there should be a
40 percent chance that the 1800 GMT wind direction at Marlinton will
be from the northwest and 68 percent likelihood of being from the
northwest quadrant.)

4. EVALUATIONS AND CONCLUSION

Table 5 lists results comparing official fire weather forecasts
(FWF) with those obtained using this objective wind forecast study
(OBJ). I feel that the official forecasts for the 1976 fire season
were greatly improved by the implementation of the techniques described
in this study.

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 9
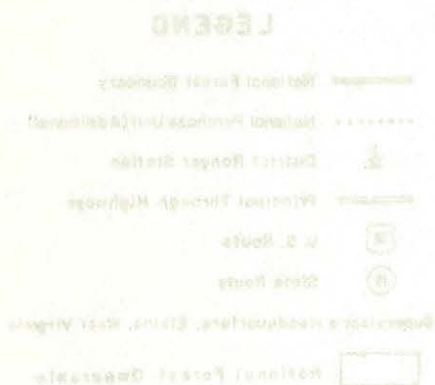
MONONGAHELA
NATIONAL FOREST

WEST VIRGINIA

GRANT, GREENBRIER, NICHOLAS,
PENDLETON, POCAHONTAS, PRESTON,
RANDOLPH, TUCKER AND WEBSTER
COUNTIES

LEGEND

National Forest Boundary
National Purchase Unit (Additional)
District Ranger Station
Principal Through Highways
U. S. Route
State Route
Supervisor's Headquarters, Elkins, West Virginia
National Forest Ownership

Figure 1

SCALE
0   5   10   15   20 MI
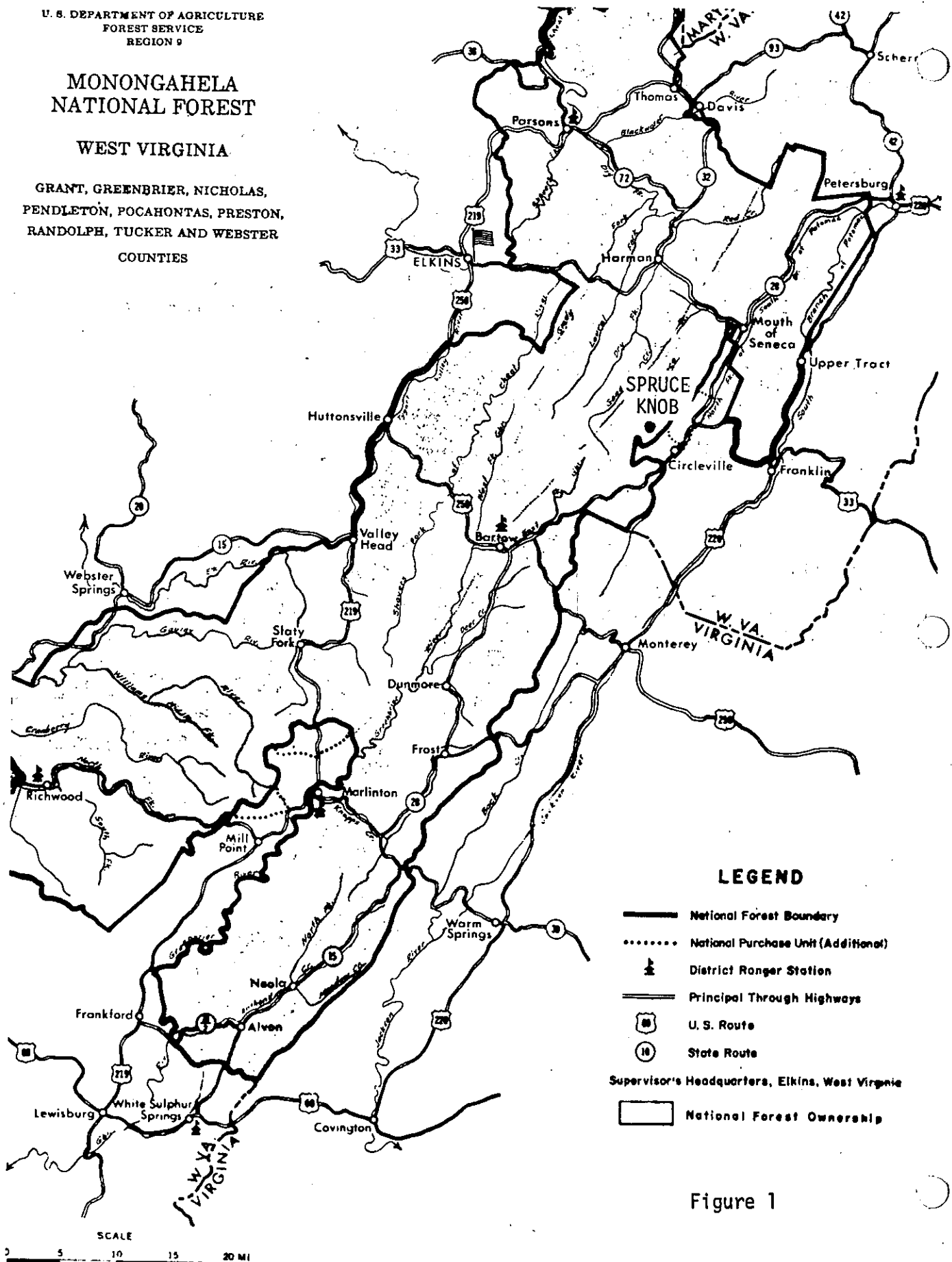
NUMBER OF CASES

	ALL	≥ 10
N	40	5
NE	14	0
E	6	0
SE	32	13
S	67	25
SW	72	35
W	98	52
NW	148	56

MPH (16 Km/h)

ALL

≥10MPH (16 Km/h)

Elkins (ALL):

N
(70)
(85) 8.5
6.8
7.3   4.7
3.9   (85)
4.5
10.2   2.3
(80)   (45)
8.4   2.5 5.2
5.6   3.3
9.7   8.1   (30)
(55)
8.6   (40)

≥10MPH:

≥10MPH (16 Km/h)

N
(45)
10.8
(90) 12.4
11.2
4.8
13.3
(75)
10.2   2.0
5.0
9.7
12.6
(75)   11.5
(15)
12.2 (40)

Figure 2. 1800 GMT AVERAGE WIND SPEED FOR EIGHT POINT COMPASS:
PETERSBURG VERSUS ELKINS, WEST VIRGINIA. NUMBER IN
PARENTHESES WOULD INDICATE PERCENTAGE OF ELKINS WIND
SPEED FORECAST APPLIED TO PETERSBURG.

(Elkins wind rose is solid ▬▬▬ Petersburg wind rose is striped ▨▨ .)

NUMBER OF CASES

	ALL	≥ 10 MPH (16 Km/h)
N	33	4
NE	12	0
E	5	0
SE	17	9
S	35	16
SW	57	29
W	71	44
NW	123	48

DATA SOURCE: SPRING FIRE SEASON 1971 THRU FALL 1972 SPRING 1974 THROUGH SPRING 1975
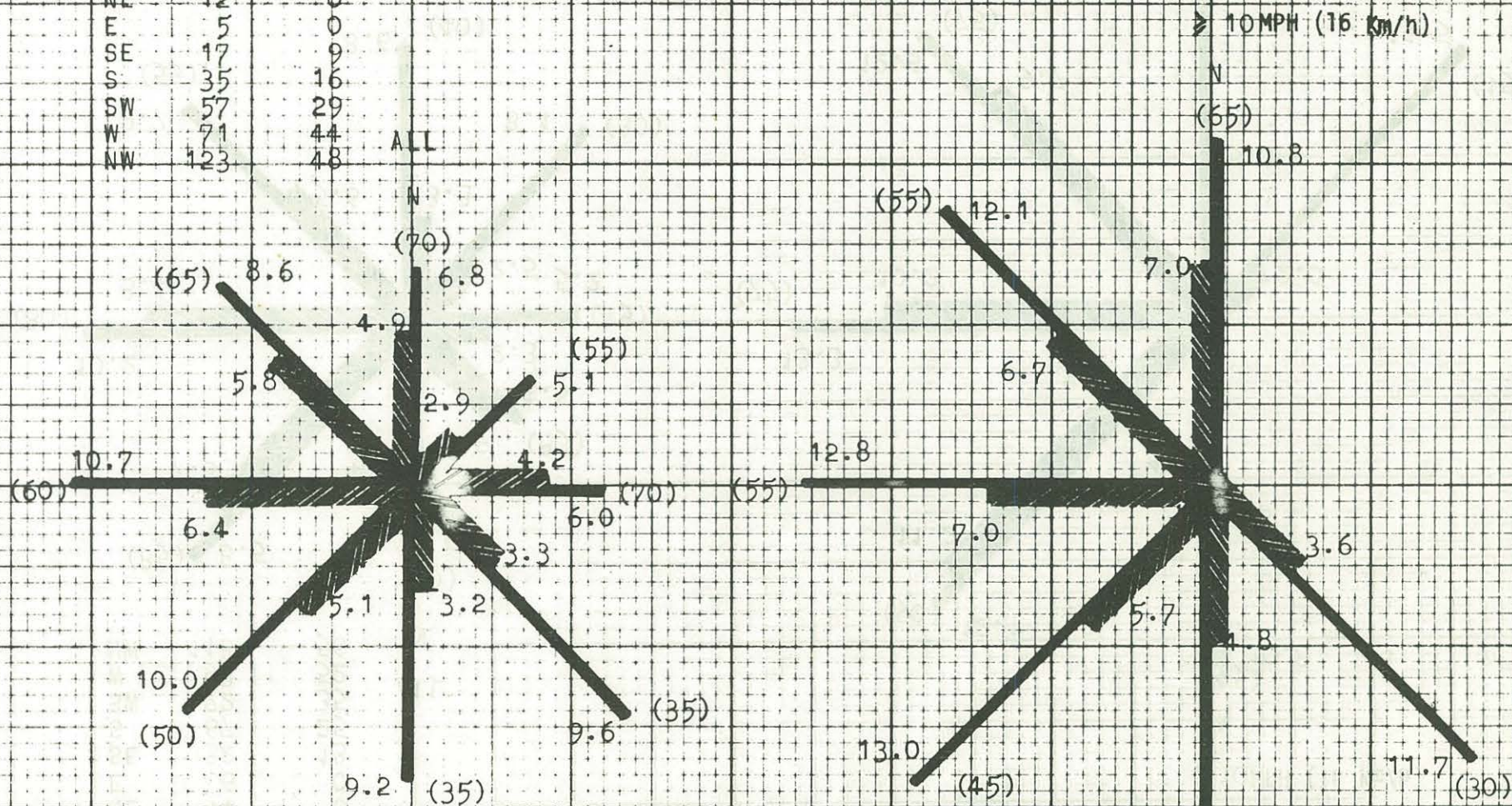
Figure 3. 1800 GMT AVERAGE WIND SPEED FOR EIGHT POINT COMPASS: MARLINTON VERSUS ELKINS, WEST VIRGINIA. NUMBER IN PARENTHESES WOULD INDICATE PERCENTAGE OF ELKINS WIND SPEED FORECAST APPLIED TO MARLINTON.

(Elkins wind rose is solid. Marlinton wind rose is striped.)

DATA SOURCE: SPRING FIRE SEASON 1970 THRU FALL 1972
SPRING 1974 THRU SPRING 1975

> 10 MPH (16 Km/h)

NUMBER OF CASES

	ALL	≥ 10 MPH (16 Km/h)
N	38	4
NE	13	1
E	7	0
SE	26	11
S	58	19
SW	66	32
W	93	43
NW	148	56
ALL		
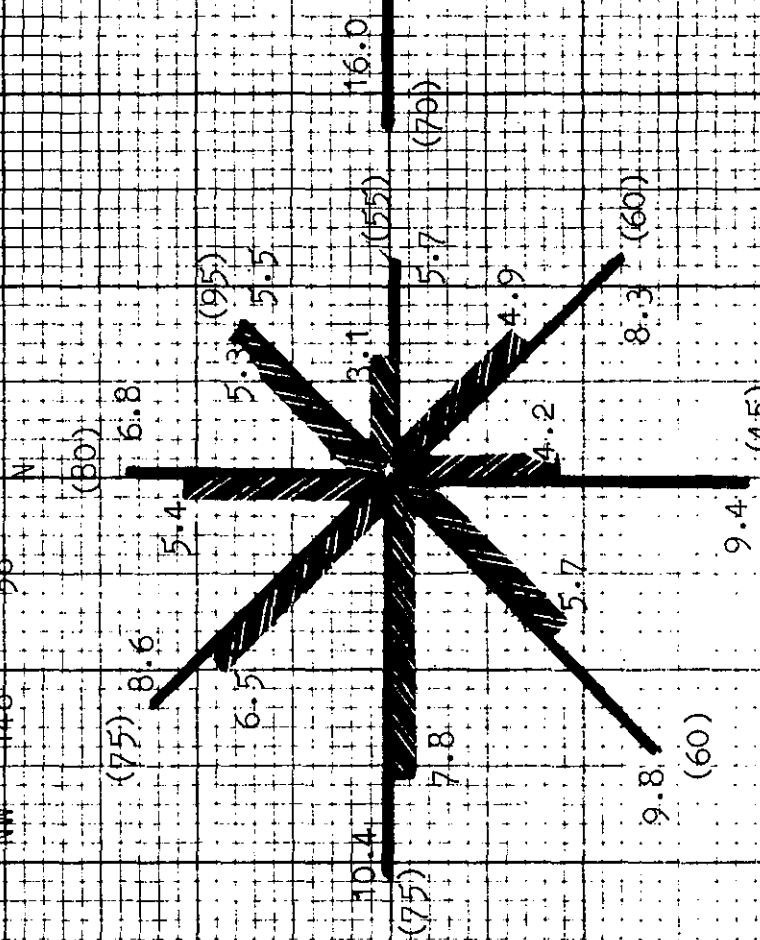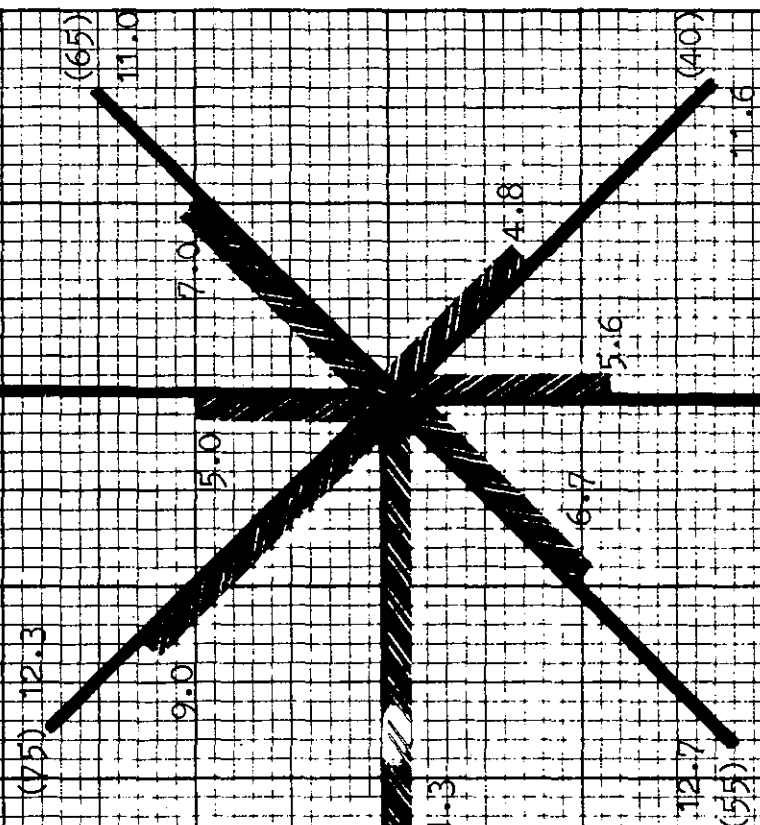
Figure 4. 1800 GMT AVERAGE WIND SPEED FOR EIGHT POINT COMPASS:
BARTOW VERSUS ELKINS, WEST VIRGINIA. NUMBER IN
PARENTHESES WOULD INDICATE PERCENTAGE OF ELKINS WIND
SPEED FORECAST APPLIED TO BARTOW.
(Elkins wind rose is solid ▬▬. Bartow wind rose is striped ▨▨.)

Figure 5. Distribution of 1800 GMT wind directions observed at Petersburg (on wind roses) for each of the eight point compass 1800 GMT wind directions observed at Elkins, WV.

Percent (number of observations)

N (39)

18(7)
26(10)   5(2)
13(5) _____ 0(0)
13(5)   5(2)
3(1)

Calm 18(7)

NE (14)

0(0)
14(2)   29(4)
14(2)   0(0)
14(2)   14(2)
7(1)

Calm 7(1)

E(10)

0(0)
0(0)   0(0)
0(0)   0(0)
0(0)   0(1)
20(2)

Calm 70(7)

SE(38)

3(1)
16(6)   3(1)
13(5)   3(1)
11(4)   3(1)
3(1)

Calm 47(18)

S(53)

2(1)
9(5)   0(0)
9(5) _____ 2(1)
11(6)   3(7)
2(1)
Calm 51(27)

SW(73)

3(2)
21(15)   4(3)
27(20)   0(0)
14(10)   7(5)
11(8)
Calm 14(10)

W (91)

3(3)
33(30)   4(4)
30(27)   1(1)
11(10)   4(4)
5(5)
Calm 8(7)

NW (159)

2(3)
31(50)   6(9)
30(48)   1(2)
9(15)   8(13)
1(2)
Calm 11(17)
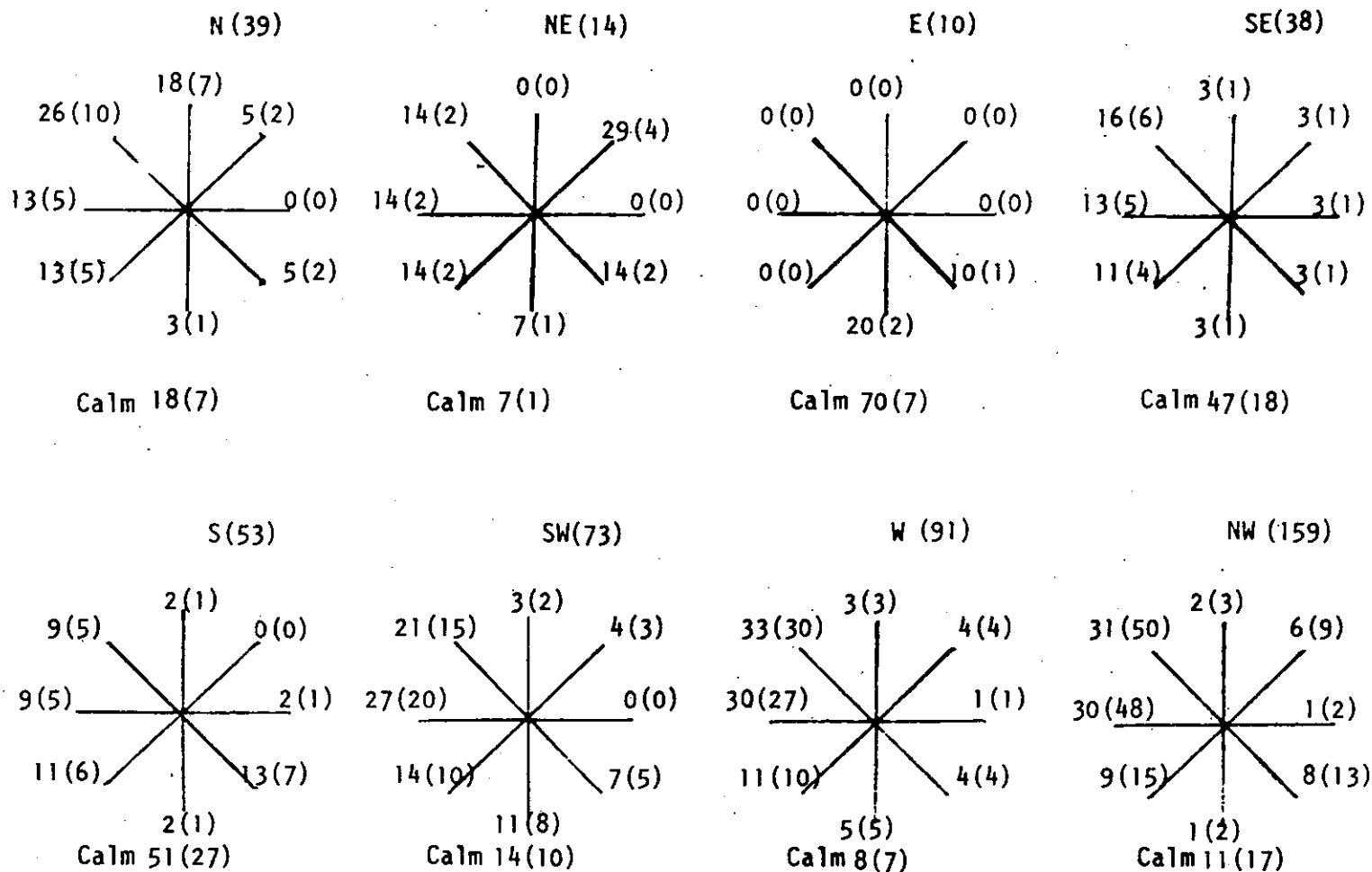
477 cases = Spring 1970 through Fall 1972 and Spring 1974 through Spring 1975.

Figure 6. Distribution of 1800 GMT wind directions observed at Marlington (on wind roses) for each of the eight point compass 1800 GMT wind directions observed at Elkins, WV.

Percent (number of observations)

N (37)

30(11)
16(6)   14(5)
14(5)   8(3)
8(3)   8(3)
3(1)

Calm 0(0)

NE (12)

17(2)
25(3)   8(1)
8(1)   0(0)
33(4)   8(1)
0(0)

Calm 0(0)

E (6)

17(1)
17(1)   0(0)
0(0)   0(0)
0(0)   17(1)
33(2)

Calm 17(1)

SE (18)

11(2)
11(2)   17(3)
11(2)   0(0)
0(0)   28(5)
0(0)

Calm 22(4)

S (35)

3(1)
3(1)   9(3)
23(8)   0(0)
31(11)   3(1)
17(6)

Calm 11(4)

SW (67)

7(5)
12(8)   1(1)
25(17)   4(3)
27(18)   7(5)
10(7)

Calm 4(3)

W (71)

10(7)
30(21)   4(3)
21(15)   4(3)
18(13)   4(3)
6(4)

Calm 3(2)

NW (126)

15(19)
40(50)   7(9)
13(17)   2(3)
18(23)   2(3)
1(1)

Calm 1(1)
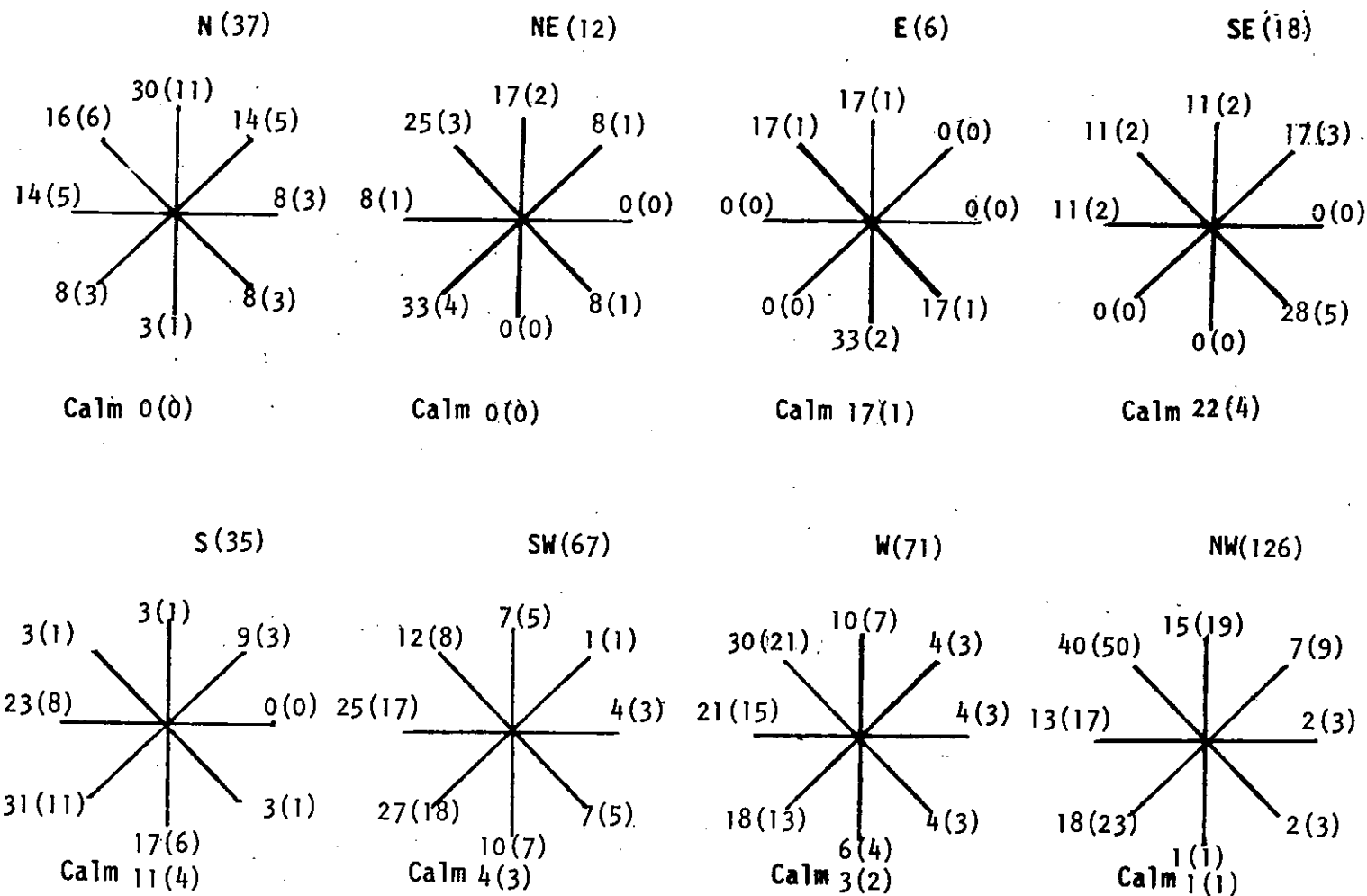
372 cases - Spring 1971 through Fall 1972 and Spring 1974 through Spring 1975.

Figure 7. Distribution of 1800 GMT wind directions observed at Bartow (on wind roses) for each of the eight point compass 1800 GMT wind directions observed at Elkins, WV.

Percent (number of observations)

N (38)

```
        -0(0)
5(2)           5(2)
50(19)         18(7)
11(4)          11(4)
        0(0)
```
Calm 0(0)

NE (21)

```
        0(0)
5(1)           0(0)
33(7)          5(1)
5(1)           5(1)
        0(0)
```
Calm 48(10)

E (7)

```
        14(1)
14(1)          0(0)
29(2)          0(0)
43(3)          0(0)
        0(0)
```
Calm 0(0)

SE (24)

```
        0(0)
4(1)           4(1)
42(10)         25(6)
25(6)          0(0)
        0(0)
```
Calm 0(0)

S (54)

```
        4(2)
0(0)           0(0)
50(27)         2(1)
28(15)         4(2)
        2(1)
```
Calm 11(6)

SW (65)

```
        2(1)
14(9)          2(1)
34(22)         2(1)
31(20)         6(4)
        6(4)
```
Calm 5(3)

W (87)

```
        1(1)
11(10)         1(1)
52(45)         3(3)
24(21)         6(5)
        0(0)
```
Calm 1(1)

NW (153)

```
        2(3)
13(20)         3(5)
54(82)         3(5)
17(26)         5(7)
        1(2)
```
Calm 2(3)
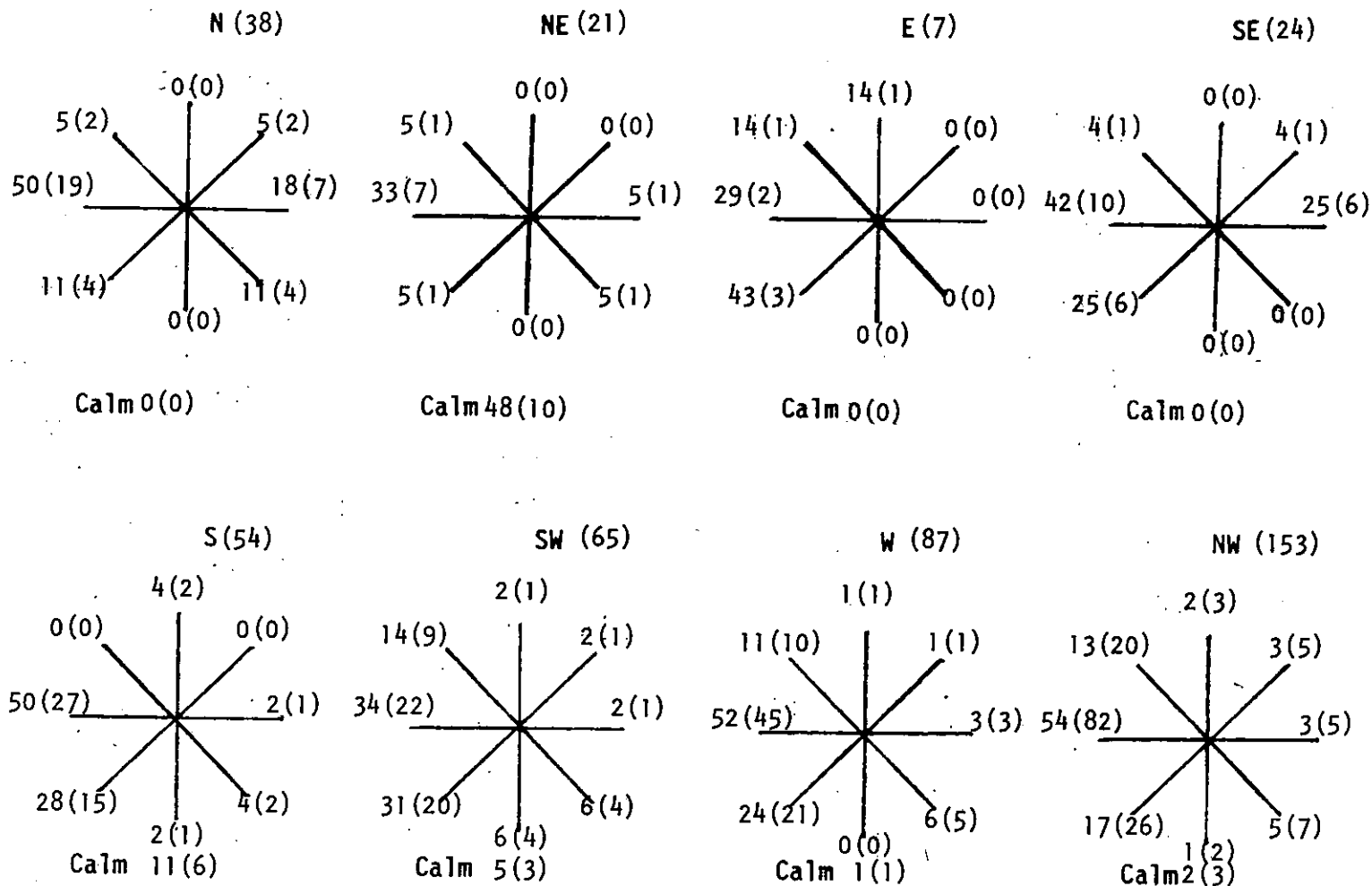
449 cases - Spring 1970 through Fall 1972 and Spring 1974 through Spring 1975.

MONTH	1974					1975					COMBINED				
	NUM FCST	TOT ABS ERR	AVG ABS ERR	TOT ALG ERR	AVG ALG ERR	NUM FCST	TOT ABS ERR	AVG ABS ERR	TOT ALG ERR	AVG ALG ERR	NUM FCST	TOT ABS ERR	AVG ABS ERR	TOT ALG ERR	AVG ALG ERR
JAN	18	58	3.2	+14	+0.8	17	74	4.4	+20	+0.6	35	132	3.8	+24	+0.7
FEB	18	53	2.9	+22	+1.2	16	43	2.7	+19	+1.2	34	96	2.8	+41	+1.2
MAR	20	57	2.9	+27	+1.4	17	44	2.6	+10	+0.6	37	101	2.7	+37	+1.0
APR	19	62	3.3	+ 6	+0.3	20	46	2.3	-12	-0.6	39	108	2.8	- 6	0.0
MAY	22	70	3.2	+24	+1.1	21	65	3.1	+27	+1.3	43	135	3.1	+51	+1.2
JUN	20	40	2.0	+ 9	+0.5	19	43	2.3	+33	+1.7	39	83	2.1	+42	+1.1
JUL	20	43	2.2	+27	+1.4	14	40	2.9	- 4	-0.3	34	83	2.4	+23	+0.7
AUG	23	54	2.3	-28	-1.2	10	34	3.4	- 4	-0.4	33	88	2.7	-32	-1.0
SEP	26	69	2.7	-45	-1.7	17	41	2.4	+ 1	+0.1	43	110	2.6	-44	-1.0
OCT	31	103	3.3	-14	-0.5	15	29	1.9	-21	-1.4	46	132	2.9	-35	-0.8
NOV	28	63	2.3	+33	+1.2	18	68	3.8	+ 9	+0.5	46	131	2.8	+42	+0.9
DEC	24	86	3.6	+ 6	+0.3	14	56	4.0	- 3	-0.2	38	142	3.7	+ 3	+0.1
AVERAGE											38.9	111.8	2.9		+0.3

Table 1. 42-hour 0000 GMT FO22 Wind Speed (knots) Verification for Elkins, West Virginia: 1974 - 1975.
(To convert knots to kilometers per hour (km/h) multiply by 1.85.)

		NE	E	SE	S	SW	W	NW	N	TOT	PCT FCST	PCT HIT
	NE		3	1				2	2	8	2	0
	E			6			2	1	1	10	2	0
F	SE			3	2			1	1	7	2	43
C	S	2		4	13	6	7	3		35	8	37
S	SW	2	2	4	12	18	15	9	1	63	15	29
T	W	4	2	4	22	41	58	50	20	201	46	29
	NW	6	3	2	6	2	16	36	11	82	19	44
	N		1	2	4		7	12	1	27	8	3
TOT										433		

Table 2. 42-hour 0000 GMT F022 Wind Direction Verification for Elkins, West Virginia: 1974-1975. (PCT HIT is identical to the post agreement score [hits/forecast].)

		S	SW	W	NW	N	TOT
	250	1	6	7		3	17
	260	4	8	12	2	2	28
F	270	5	11	13	7	3	39
C	280	6	9	11	12	4	42
S	290	5	4	6	18	4	37
T	300	2	3	9	12	3	28
	TOT			58			191

Table 3. Comparison of 42-hour 0000 GMT F022 Forecasts of Wind Directions (in degrees) during 1974 and 1975 with Observed Wind Directions for the westerly half of an Eight Point Compass for Elkins, West Virginia.

Table 4. Verification of ELKINS WV FO22 Wind Speeds 42 Hours From 0000 GMT For 1974 and 1975

Forecast Direction	All Speeds		Forecasts >8 kts (≥15 km/hr)		Forecasts >10 kts (>19 km/h)		Forecasts >12 kts (≥22 km/h)	
	Percentage Correct	Number of Forecasts Evaluated	Percentage Correct	Number Correct	Percentage Correct	Number Correct	Percentage Correct	Number Correct
030-140	77	22	71	7				
150-200	70	36	58	14	33	3	50	2
210	58	12	67	5	100	2		
220	72	18	77	13	83	6	100	1
230	64	14	60	10	80	5	0	1
240	67	21	63	16	50	8	50	2
250	50	26	44	18	40	10	67	3
260	70	40	58	26	78	9	67	3
270	56	41	59	27	54	13	57	7
280	68	44	67	24	73	11	75	4
290	70	43	69	28	63	8	100	3
300	81	36	81	16	86	7	100	2
310	89	19	100	5	100	1	100	1
320	78	36	80	5				
330	78	18	67	3				
340-020	69	29	57	7				
ALL	68	455	65	222	64	84	71	28

Note: A correct forecast was defined as one that was within ± 3 kts (6km/h) of the observed wind speed.

Table 5.   Verification comparing official FIRE Weather Wind Speed Forecasts (FWF) with results obtained using the OBJECTIVE (OBJ) Monongahela National Forest Wind Technique.

A.   Spring Fire Season Forecasts, March 5 thru May 15, 1976

	BARTOW		MARLINTON		PETERSBURG	
	FWF	OBJ	FWF	OBJ	FWF	OBJ
Number of Forecasts	70	70	70	70	70	70
Total Error (mph)	179	195	150	154	222	223
Average Error (mph)	2.6	2.8	2.1	2.2	3.2	3.2
Mean Observed Wind (mph)	6.2		5.0		8.1	

B.   Fall Fire Season Forecasts, October 15 thru November 30, 1976

	BARTOW		MARLINTON		PETERSBURG	
	FWF	OBJ	FWF	OBJ	FWF	OBJ
Number of Forecasts	39	39	39	39	40	40
Total Error (mph)	101	102	105	99	141	142
Average Error (mph)	2.6	2.6	2.7	2.5	3.5	3.6
Mean Observed Wind (mph)	5.3		4.0		7.6	

C.   Summary comparing earlier FIRE Season Wind Speed Forecasts (before use of the objective technique) with the 1976 FIRE Season Wind Speed Forecasts when the objective (OBJ) technique was used. (Wind speeds are in miles per hour (mph).)

	BARTOW		MARLINTON		PETERSBURG	
	FWF	OBJ	FWF	OBJ	FWF	OBJ
Spring 1974	3.2		2.3		4.4	
Fall 1975	3.6		3.5		3.8	
Fall and Spring 1976		2.7		2.3		3.3

Note: To convert mph to Km/h multiply by 1.6.